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ABSTRACT

Examined in this paper are some of the factors which presently interact with, and which will continue to interact with, the transfer of technological information, with particular emphasis on those factors which play on the role of the university faculty member. Among these factors are the composition and goals of the student population the faculty member will face, demands made on public agencies and institutions of higher learning, the tendency toward conflict between intradisciplinary and interdisciplinary cohesiveness among faculty, and some methodological approaches which can be used in achieving technology transfer. The National Aeronautics and Space Administration and American Society for Engineering Education (NASA-ASEE) Engineering Systems Design Approach is highlighted as an innovative concept which can be used as an effective model for sensitizing discipline-oriented faculty members to their responsibilities in the understanding and transfer of scientific and technological information to meet social needs. (RB)ch

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THE ROLE OF UNIVERSITY FACULTY IN THE TRANSFER OF TECHNOLOGICAL INFORMATION

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Whether to develop a hypersonic research engine capable of propelling a titanium-skinned aircraft at Mach 7 to determine new stall/spin criteria for light twin-engine general aviation aircraft, to map ocean roughness qualities using a sophisticated satellite-borne microwave radar system, or to adapt the use of nose cone heat-shield material to construct pipe bowls, the transfer of relevant scientific, engineering, and technological information both within and without the scientific community is of concern as we advance toward the 21st century.

The purpose of this paper is to examine some of the factors which presently interact with, and which will continue to interact with, the transfer of technological information with particular emphasis on those which play upon the role of the university faculty member. Among these factors are the composition and goals of the student population the faculty member will face; demands made upon public agencies (particularly upon institutions of higher learning;) the tendency toward conflict between intra-group cohesiveness and inter-group cooperation among faculty; and, some methodological approaches which can be used in achieving technology transfer. The paper will highlight an approach used successfully by the National Aeronautics and Space Administration and the American Society for Engineering Education (NASA-ASEE).

The Student Population

In the past few years, two major events have occurred which will affect the student population in the latter part of this century. First, because of a decreased birthrate in the United States, the college student pool will diminish.[1] Second, because of the diminished pool, there have been, and will continue to be, national policy shifts in the direction of expanding educational entitlement.

By using data provided by the U.S. Bureau of the Census one can determine that nearly one-fourth of the U.S. population growth from the mid-1960's to the mid-1970's was in the traditional college-level age group (approximately 18-24); that from the mid-1970's to the mid-1980's this age group will represent only about one-tenth of the total U.S. population. The U.S. Bureau of the Census has reported that

> Restricting consideration to cohorts already born, the population 5 to 13 will decline during the remainder of the 1970's, the population 14 to 17 will decline through the 1980's, and the population 18 to 24 will increase during the remainder of the 1970's and then decrease during the 1980's and early 1990's.[2]

Certainly by 1990, we will see an overall decrease in the number of traditional college-age citizens. The 1990 pool is constant. Although one might project an increase by the year 2000, such an assumption would have no basis in fact as of this date since that population is not yet born.

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[1]Executive Office of the President: Office of Management and Budget, Social Indicators, 1973, U.S. Government Printing Office, Washington, D.C., p. 238.

[2]U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 601, "Projections of the Population of the United States: 1975 to 2050," U.S. Government Printing Office, Washington, D.C., 1975, p. 7.

From 1956 to 1972, the annual rate of population growth in the United States fell from 1.8 percent to 0.8 percent.[3] On July 1, 1974 the population increase in the United States had dropped to a rate of 0.7 percent, ". . . equal to the historically low rate of the 1930's."[4] The most optimistic projections by the U.S. Bureau of the Census call for a population growth rate between 1.0 and 1.1 percent in the year 2000; with the same growth rate for 2025. The most negative projections are 0.2 to 0.3 percent by 2000; and, -0.1 percent by 2025.[5]

Since the pool of traditional students will decrease, colleges and universities will seek to increase their student base. Even today there is evidence of the awareness of large, relatively untapped sources of non-traditional students. For example, universities are developing special two and three year courses of study in fields like law enforcement technology and, mental health technology—in general, the training of paraprofessionals —in order to meet the expressed needs of both the profession and the student who otherwise might avoid higher education altogether. Divisions of Continuing Education or Extended Education are seeking out students for specialized courses (but not programs of study leading to a degree). Universities are reaching out to reattract the housewife who, with children now grown, needs only one year of coursework to complete a Bachelor's degree. With the identification of non-traditional student populations the number of undergraduate

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[3] Op. Cit., Executive Office of the President, p. 223.

[4] Op. Cit., U.S. Bureau of the Census, p. 7.

[5] Ibid., p. 3.

students may remain constant or even increase slightly.[6]

Graduate and professional programs will continue to grow, but only if built on a strong undergraduate base. Growth in numbers is not necessarily desirable. Growth in quality is desirable. Imagine, for example, the year 1980 by which time the approximately 1,000 journalism students currently enrolled in academic-programs join the nearly 160,000 practicing journalists already on the job. Or take the engineering profession, usually one where jobs are plentiful. According to data compiled by the Engineering Manpower Commission of the Engineers Joint Council, in June 1975, 12 percent of those with new Bachelor's degrees in engineering did not have jobs by Spring commencement; 7 percent of those with Master's degrees; and, 8 percent of those with Doctoral degrees.[7]

Demands Upon Public Agencies

The public demands that there be an awareness of, and responsiveness to, environmental and social issues in the quality of decision-making affecting the public sector. In an era of rapid change, public agencies will have to act with greater haste than in the past, yet without sacrificing thoroughness. Moreover, as agencies are made aware of new data, they must be prepared to modify previously held positions even in the face of public criticism charging inconsistency. The public agency (and here, the public university is no

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[6]Op. Cit., Executive Office of the President, pp. 86-94, 96-98.

[7]"Reduced Hiring Hits Engineering Graduates," The Chronicle of Higher Education, Vol. XI, No. 8, November 3, 1975, p. 2.

different) may have to adopt behavior similar to the decision-maker who, upon changing his mind, was promoted to say, "I'm a lot smarter today than I was last year when I made the original decision."

Leadership in technological information transfer must be assumed by many. No single sector can be solely responsible for the charge or solely capable of its achievement. In universities, the intellectual potential of faculty resources must be used. Unfortunately, many faculty who might otherwise be productive transferers, today are forced by the realities of budget cuts, loss of support personnel and increasing administrative costs to spend inordinate amounts of time and effort in activities other than the processing of ideas and the pursuit of truly intellectual endeavors.

The 1975 Ladd-Lipset Survey revealed that U.S. Faculty Members viewed themselves as "teachers" and "professionals," not as "scholars" and "intellectuals." The connotations of teacher and professional were involvement in actual classroom instruction, administration, and in communicating knowledge rather than developing it. Involvement in research was the connotation for scholar and intellectual. The survey reported that ". . . For every one professor strongly devoted to research, there are nine equally devoted to teaching."[8] There is no attempt here to pass judgment on faculty self-perceptions, but rather to question how it is possible for the individual faculty member, no matter how he describes himself, to function productively (using his intellectual capability) when so little of his time may be spent generating, conceptualizing, or processing new information.

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[8]Ladd, Everett Carll,Jr., and Seymour Martin Lipset, "How Professors Spend Their Time" (The 1975 Ladd-Lipset Survey of U.S. Faculty Members), The Chronicle of Higher Education, Vol. XI, No. 5, October 14, 1975, p. 2.

Intra-Group/Inter-Group Conflict

Ten years ago, Allen presumed that there was general agreement that communication channels between and among the scientific and technical community were performing at levels below optimum. In an experimental study of channels used for transferring technological information, Allen found that those sources within the laboratory (such as the technical staff and/or specific company research programs) performed better than sources outside the laboratory (such as "the literature").[9] One implication Allen noted was a possible tendency for a loss of communication efficiency (and presumably effectiveness) in an inter-disciplinary setting as compared with an intra-disciplinary setting. Academicians, perhaps like steel workers, perceive a greater fraternity among others in their discipline than with the organization in which they work; or, phrased differently, engineers are more likely to associate with other engineers than with behavioral/social scientists.

The 1975 Ladd-Lipset Survey supported this notion:

> Once within a field, faculty members become subject to powerful forces of professional socialization.
> . . . . . .
> Once a faculty member enters a discipline he is subject to an elaborate process of reinforcement.[10]

Allen and Cohen concluded that within a technical communication network, the gatekeepers of technological information who provide others with data either have more contacts with people outside the organization or are

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[9]Allen, Thomas J. "Performance of Information Channels in the Transfer of Technology," Industrial Management Review, Vol. 8, Fall 1966, pp. 87-98.

[10]Ladd, Everett Carll, Jr., and Seymour Martin Lipset, "Professors, Politics, and Academe's Internal Logic," The Chronicle of Higher Education Vol. XI, No. 8, November 3, 1975, p.2.

more familiar with the literature than are other members of their own organization.[11] The implication here for interdisciplinary study, and hence the transfer of technological information, is that information gatekeepers should be identified and encouraged to participate so that they may bring information back to their parent organization for distribution. In this context, concepts of interpersonal trust, source credibility, and small-group process are identified as components of the technological information system. Additionally, the flow of information, communication channel selection, and information, overload are considered.[12]

Some Methodological Approaches

At least four common methodological approaches are used which involve university faculty in the process of transferring scientific and technological information into broad-based societal use: (1) Congressional mechanisms, (2) professional associations, (3) university research centers and institutes, and (4) interdisciplinary courses.

(1) Congressional Mechanisms: Congressional mechanisms such as open or closed hearings, the calling of "experts" (often academicians) to testify about present or anticipated social problems influenced by technology has little direct impact on the public. Dissemination of arguments on issues

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[11]Allen, Thomas J., and Stephen I. Cohen. "Information Flow in Research and Development Laboratories," Administrative Science Quarterly, Vol. 14, 1969, 12-19.

[12]Schuelke, L. David, Mark Gonzalez, and William Koentopp. "Scientific Communication in the Urban Environment: Implications for Political Decision Making," Paper, Annual Conference, International Communication Association Chicago, Illinois, April 24, 1975, p. 17.

ke the SST and ozone layer depletion depend less on the committee hearing or formal report than on popular print and broadcast media. Even then, understanding of the issue(s) is/are often biased, inaccurate, and uninformed.

(2) Professional Associations: By their nature, professional associations are formed to represent the interests of a particular class. As the association matures, often it will attempt to accommodate the pluralities within its membership by programming to their particular needs. Occasionally an association splinters, it factions becoming new associations of their own. Rarely will a professional association possess an interdisciplinary integration; often parochialism abounds.

Behavioral scientists from sociology, communication, and psychology may interact with each other at an American Psychological Association convention. The odds are against these individuals interacting with groups of engineers at the same meeting since engineers will be absent. Even a group like the American Association for the Advancement of Science, composed of multiple interests representing a very high number of areas of academic inquiry will have members who choose to attend only those programs within their own academic field.

(3) University research centers and institutes: Many of us may be aware of the high visibility research centers and institutes concerned with public policy and decision-making of Harvard, Duke, Michigan, at George Washington, and Berkeley. The Communication Research Center at Purdue (active since the mid-1950's), the Center for Communication Studies at Ohio University (active since the the mid-1960's), are both concerned with the communicative process as it

occurs in complex organizations (governmental, educational, business, industrial, profit-seeking, and not-for-profit). The Center for Research in Scientific Communication at the University of Minnesota (active since 1974) is believed to be the only university research center concerned solely with the study of the transfer of scientific and technical information. Most major Universities have established centers for interdisciplinary teaching and research in the area of urban and/or environmental studies. Centers and institutes like the ones mentioned above are active and viable university arms, having interdisciplinary perspectives, which attempt to integrate new knowledge into existing academic curricula and into the communities they serve.

University faculties must be made aware, and make themselves aware, of various technology sharing and assistance mechanisms, whether they be centers or institutes, or, for example, services provided by a government agency. The Department of Transportation has outlined activities in which it engages to share technology and provide technical assistance. Of their list of three activities, the first is to "Communicate with state/local governments, private industry and universities regarding their technology information needs."[13]

Similar efforts which are related to technology utilization, sharing and transfer have been made through such activities as the intergovernmental Science Programs of the National Science Foundation, the NASA Technology Utilization Program, the Technology Application Program of the International City Manager's Association and the U.S. Conference of Mayors, and the National Action Conference on Intergovernmental Science and Technology Policy.

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[13] Technology Sharing, U.S. Department of Transportation, Washington, D.C., January 1976, p. 5.

Like the Department of Transportation's technology-sharing mechanism, most university centers and institutes would probably subscribe to the needs for (1) field support and direct assistance, (2) information services, (3) training programs, and (4) research, development, and demonstration (RD & D) projects.[14]

(4) Interdisciplinary courses. Garg has argued that broadly-based societal problems be assessed in contemplating the introduction of any new technology:

> Traditional education in the physical and engineering sciences has long ignored sociological considerations in professional work. Similarly, social sciences have tended to neglect the methodological contribution of engineering sciences to the study of societal issues. . . . The understanding of how society works in relation to both technological and human value potential is of paramount importance and should be dealt with by the sociologist and engineers working together as a team.[15]

Garg's approach, one used successfully at a number of academic institutions, is the development of interdisciplinary courses, taught and taken by hard scientists, engineers, social and behavioral scientists, and so-called "humanists," thus sensitizing each to the needs of the other while assuring greater understanding of the science of technology and its implications than would be possible with a more limited approach.

Not only has this appraoch been useful in the classroom setting, but also it has had utility when coupled with engineering systems design concepts developed jointly by NASA-ASEE. This particular approach mechanism

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[14]Ibid, pp. 5-6.

[15]Garg, Devendra P. "A Societal Course in Technology Assessment," IEEE Transactions in Education, Vol. E-17, No. 3, August 1974, pp. 157-161.

is sufficiently meritorious to warrant special consideration here as a method of developing faculty capabilities with respect to their involvement in the transfer of scientific and technological information.

NASA-ASEE Engineering Systems Design Projects

During the summer of 1965, the National Aeronautics and Space Administration, in conjunction with the American Society for Engineering Education, sponsored the first Summer Faculty Fellowship Program in Engineering Systems Design[16] which was conducted jointly by the NASA-Ames Research Center and Stanford University.[17] Including that first program, through the summer of 1975, there were 36 systems design programs conducted at four NASA Research Centers, involving approximately 675 participants (including college and university professors and students), and perhaps 10 NASA center/university co-directors. These programs have cost NASA approximately $3.5 million.[18] Hidden costs, such as at least one half-time NASA technical advisor assigned to each project, supplies, and use of the Federal Telephone System are additional.

As expressed in the 1976 Bulletin describing the NASA-ASEE Summer Faculty Fellowsnip program, its engineering systems design objectives are:

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[16]Baumar, Dwight, et al., Interdisciplinary Research Topics in Urban Engineering. A report by the Urban Engineering Study Committee of the American Society for Engineering Education (NSF Grant GK-15688).

[17]Ibid., p. 22.

[18]1975 estimates of participants/expenditures are included in this statement. 1964-1974 data are found in the Summary Report of the Chairman ASEE Space Engineering Committee, 01 July 1973 - 30 June 1974.

(1) to increase competence and to develop concepts which will enable participants to organize multidisciplinary engineering systems design programs and courses at their home institutions; (2) to establish and to further communication and collaboration between engineering and other disciplines; and, (3) to create definitive engineering systems design.[19]

From 1973 through 1975, the period during which the authors have been associated with NASA-ASEE design projects (in the roles of Project Manager, Assistant Project Manager, and participant at the Langley Research Center LaRC) the following studies have been conducted:

1. The Energy Dilemma and its Impact on Air Transportation, 1973.[20]
2. Urban Transportation: Perspectives on Mobility and Choice, 1974.[21]
3. General Aviation and Community Development, 1975.[22]

Participants in these three programs have represented 75 colleges and universities and 30 academic disciplines. Exclusive of support personnel more than 100 individuals have come from 31 states.

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[19]NASA-ASEE Summer Faculty Fellowships, 1976, brochure, back cover.

[20]Dyer, Calvin R., Michael Z. Sincoff, and Paul D. Cribbins (eds.), The Energy Dilemma and its Impact on Air Transportation, NASA Contract NGT 47-003-028, published by NASA and Old Dominion University, 1973.

[21]Sincoff, Michael Z., Jarir S. Dajani, and Curtis M. Brooks (eds.), Urban Transportation: Perspectives on Mobility and Choice, NASA Contract NGT 47-003-028, published by NASA and Old Dominion University, 1974.

[22]Sincoff, Michael Z., and Jarir S. Dajani (eds.), General Aviation and Community Development, NASA Contract NGT 47-003-028, published by NASA and Old Dominion University, 1975.

Approximately 50 guest speakers have addressed the groups or held seminars with them. They have represented federal, state, and local governmental agencies; public and private institutions, and, lobby groups.

The benefits and spin-offs of the NASA-ASEE system design projects include, but are not necessarily limited to, the following:

1. Benefits to project participants, in terms of the enrichment of their professional careers, interdisciplinary design and analysis capabilities, and changes in research interest.

2. Benefits to the home institutions of project participants, with respect to the development of new teaching materials courses and approaches as well as new research capabilities.

3. Benefits to NASA, in terms of improved university and community relations, the generation of innovative ideas, the potentially useful interaciton between and among project participants and research center scientists and engineers, and the development of new management systems technology.

4. Benefits to the communities in which the research centers are located, in terms of studies directly addressing and influencing community issues, and in terms of improved NASA-Community relations.

5. Benefits to readers and users of the resulting reports and documents in both government and industry.

Conclusion

This paper has discussed some of the factors the university faculty member is likely to encounter as he performs his role in the transfer of technological information. Factors considered included the student population demands made upon public agencies, and inter-group vs. intra-group conflict. Some methodological approaches which might be effective in the preparation of future faculty members for their role as members of interdisciplinary transfer teams were discussed. The NASA-ASEE Engineering Systems Design Approach was highlighted as an innovative concept which presents itself as an effective model for sensitizing discipline-oriented faculty members to their responsibilities in the understanding and transfer of scientific and technological information to satisfy societal needs.

Inevitably, the conclusion must be reached that one of the paramount challenges facing higher education in the future, is the preparation of a new generation of students and teachers for careers relating to the transfer of scientific and technological information. Whether they be students in engineering, science, the social and/or behavioral sciences, or the humanities, they must be prepared to integrate technological information with human and ethical values on the one hand, and with societal needs on the other. In order to provide such an education in the future, emphasis must be placed on the preparation of faculty members who are themselves both sensitive and responsive to those issues, and who are willing and able to move beyond the limits of their respective academic disciplines in their pursuit of these objectives. Both the universities and the public sector must provide the initiative and the momentum to prepare faculty members for the assumption of their role in the creation and transfer of public technology.